UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/499,037	02/07/2000	Kazuhiro Aihara	49657-551	9656

20277 7590 07/18/2002

MCDERMOTT WILL & EMERY
600 13TH STREET, N.W.
WASHINGTON, DC 20005-3096

EXAMINER	
MONDT, JOHANNES P	
ART UNIT	PAPER NUMBER
2826	

DATE MAILED: 07/18/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/499,037	Applicant(s) AIHARA ET AL.
	Examiner Johannes P Mondt	Art Unit 2826

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 June 2002* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-6* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3* is/are rejected.

7)☒ Claim(s) *4-6* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Response to Amendment

Applicant's request for reconsideration of the finality of the rejection of the last Office action through the Appeal Brief filed 6/62002 is persuasive and, therefore, the finality of that action is withdrawn. Amendment B filed 3/22/2002 has therefore been entered (as Paper No. 8). Therefore, a new non-final rejection is herewith issued, with apologies for the delay caused by the delayed finding of the most pertinent prior art. Remarks by Applicant in traverse of the rejection of claim 1 under USC 103(a) as being unpatentable over Alers et al in view of Drynan et al are not persuasive, because Drynan et al clearly demonstrate that tungsten stands out as a material selection for interconnects including contact plugs. Furthermore, while Applicant alleges that "any material that can be used as a plug in a semiconductor device has advantageous properties" is not true, because "can be used" does not imply any specific advantage of using. Also, Applicant's motivation for the use of tungsten plug as stated on page 6 of "Remarks" is irrelevant to the determination of patentability, unlike the purpose of the additional prior art; while Applicant has no justification to conclude from the stated purpose of Applicant that unexpected results have resulted from the invention. With regard to Applicant's traverse of the rejections of claims 2-5, the examiner agrees with the traverse because of a lack of obviousness. The previous rejection of claim 1 is herewith repeated. In addition, new prior art has been found with regard to both claims 1, 2, and 3.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

2. ***Claim 1*** is rejected under 35 U.S.C. 102(e) as being anticipated by Choi et al (6,168,991 B1). Choi et al teach a semiconductor device, comprising: a contact plug including a tungsten film 14 (cf. column 4, lines 3-10) in an upper portion of the contact plug, formed on a semiconductor substrate (dielectric layer 19 (cf. column 3, lines 43-44) is formed over the field effect transistor which is inherently formed on a semiconductor substrate, in this case inter alia through HDP (cf. column 3, lines 52-57) which is understood to involve formation on a semiconductor wafer); a storage electrode 20 (cf. column 4, lines 38-56) including a tantalum nitride film serving as a barrier against copper migration into the capacitor dielectric film 22, said tantalum nitride film

being formed on and contacting an upper surface of said tungsten film; a capacitor dielectric film 22 (cf. column 4, lines 57-67) including a tantalum oxide film (cf. column 4, line 67) formed on and contacting an upper surface of said tantalum nitride film; a cell plate electrode 26 (cf. column 5, lines 20-33) including a tantalum nitride film (cf. abstract, sixth sentence) formed on and contacting an upper surface of said tantalum oxide film. In conclusion, Choi et al anticipate claim 1.

Claim 2 is rejected under 35 U.S.C. 102(e) as being anticipated by Choi et al (6,168,991 B1). Please be referred to Figure 8. Choi et al teach a semiconductor device (cf. Field of Invention, column 1, lines 16-20), comprising: a storage electrode 20 (cf. column 4, lines 38-56) including a first tantalum nitride film (cf. column 4, line 39) formed over a semiconductor substrate (dielectric layer 10 (cf. column 3, lines 43-44) is formed over the field effect transistor which is inherently formed on a semiconductor substrate, in this case through HDP (cf. column 3, lines 52-57) which is understood to involve formation on a semiconductor wafer); a capacitor dielectric film 22 (cf. column 4, lines 57-67) including a tantalum oxide film (cf. column 4, lines 65-67) formed on and contacting an upper surface of said first tantalum nitride film; a cell plate electrode 26 (cf. column 5, lines 20-33) including a second tantalum nitride film (cf. abstract, sixth sentence) formed on and contacting an upper surface of said tantalum oxide film; and a copper film 28/30 (cf. column 5, lines 60-65 and column 6, lines 18-21) formed on and contacting an upper surface of said second tantalum film. In conclusion, Choi et al anticipate claim 2.

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 1 *is rejected* under 35 U.S.C. 103(a) as being unpatentable over Alers et al (6,265,260 B1) in view of the publication by Drynan et al (ISBN: 0-7803-4774-9). With reference to Fig. 1, Alers et al teach a semiconductor device (see "Field of Invention", column 1, lines 12-14) comprising:

a via or contact plug 26 (column 3, lines 15-17) formed on a semiconductor substrate 25 (column 3, lines 13-15);

a first electrode or storage electrode 30/31 comprising a first metal layer 30 (column 2, lines 41-41 and column 3, lines 23-28) formed on and contacting an upper surface of the contact plug 26 and in a preferred embodiment allowed (column 3, lines 27-29) to include a tantalum nitride layer or film 31;

a capacitor dielectric layer or film consisting of a tantalum (pent)oxide (Ta_2O_5; with reference to Applicant's disclosure) layer or film 33 (column 3, lines 53-54) formed on and contacting an upper surface of the aforementioned tantalum nitride layer or film; and

a second electrode or cell plate electrode 34 may preferably comprise metal comprised in the first metal electrode or first metal layer 30 (column 4, lines 22-25) which metal layer may be tantalum nitride (column 3, lines 26-27); said cell plate electrode 34 is formed on and contacting an upper surface of said tantalum (pent)oxide film 33.

Alers et al do not specifically teach the aforementioned via or contact plug 26 to include a tungsten film for low resistance. However, the use of tungsten for contact plugs in semiconductor integrated circuit capacitors has long been familiar to those of ordinary skills in the art, as witnessed by the publication "Shared Tungsten Structures for FEOL/BEOL Compatibility in Logic-Friendly Merged DRAM", by J.M. Drynan et al. Specifically, Drynan et al teach the use of tungsten-based contact plugs and via plugs, especially in tantalum (pent)oxide – dielectric capacitors for DRAM devices (see abstract and Fig.3), which is the kind of Applicant's invention. Therefore, it would have been obvious to one of ordinary skills in the art to modify the invention of Alers et al so as to include a tungsten film as contact plug.

2. **Claim 3** is rejected under 35 U.S.C. 103(a) as being unpatentable over Kang (6,211,005 B1) in view of Drynan et al (ISBN: 0-7803-4774-9). Please be referred to Figure 7. Kang teaches a semiconductor device (cf. title, abstract, and column 7, line 23), comprising:

a semiconductor substrate 40 (cf. column 7, line 23) ;

a contact plug 52 (cf. column 6, lines 13-15) formed on the semiconductor substrate;

a storage electrode 54 (cf. column 6, lines 16-32) including a first indium oxide film (cf. column 6, lines 27-32) on and contacting an upper surface of said contact plug;

a capacitor dielectric film 56 (cf. column 6, lines 16-36) including a tantalum oxide film 56 (cf. column 6, lines 32-36), particularly an perovskite oxide such as strontium bismuth tantalum oxide (cf. column 6, line 36), said capacitor dielectric film 56 being formed on and contacting an upper surface of said first indium oxide film 54; and

a cell plate electrode 58 (cf. column 6, lines 16-26) including a second indium oxide film (cf. column 6, lines 28-32) formed on and contacting an upper surface of said tantalum oxide film 56.

Kang does not necessarily teach the contact plug to include tungsten. However, the selection of tungsten as the material for contact plugs in DRAM semiconductor capacitor structures has long been known to be advantageous because (a) of the low resistivity of tungsten and (b) favorable thermal budget, while (c) tungsten can be selected for all interconnect structures, thus reducing manufacturing costs by reducing processing steps: all these three advantages are taught by Drynan et al (cf. title, abstract and introduction, "Shared W for DRAM-Logic Convergence", page 31.6.1, lines 1-13 in the second column). Motivation for low resistivity of the interconnects (as opposed to the resistivity of the peripheral region) is ubiquitous to all DRAM capacitors including the invention by Kang as resistivity impedes response time, while processing step reduction would also reduce the cost of making the device invented by Kang. The

inventions can be combined, because the making of W contact plugs is standard in the art (see for instance Wolf et al, page 210). Therefore, success in implementing the combination can be reasonably expected.

Allowable Subject Matter

3. ***Claim 4-6*** are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

4. The following is a statement of reasons for the indication of allowable subject matter:

Claim 4 contains allowable subject matter, because the device as defined by claim 3 and as rendered unpatentable over Kang in view of Drynan et al with the storage electrode further including a tantalum nitride film formed beneath and contacting an upper surface of the tantalum oxide film has not been found in the prior art while specific teaching showing why such inclusion would be obvious has not been found in the prior art either. Although tantalum nitride films are known as barrier layers, especially with regard to copper, their role with regard to tungsten is less evident because tungsten itself is a good barrier material.

Claim 5 contains allowable subject matter, because the device as defined by claim 3 and as rendered unpatentable over Kang in view of Drynan et al with the further inclusion of a copper film formed on and contacting said second indium oxide film has not been found in the prior art while specific teaching

showing why such inclusion would be obvious has not been found in the prior art either.

Claim 6 contains allowable subject matter, at least because the device as defined by claim 5 contains allowable subject matter, while the further limitation of claim 6 has not been found in the prior art.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

JPM
July 15, 2002